# Montana Cooperative Wildlife Research Unit


Montana Department of Fish, Wildlife and Parks, USDI Fish and Wildlife Service, University of Montana, and Wildlife Management Institute cooperating.

**ANNUAL REPORT -- FY 1991**

Cover-- Musk deer (Moschus sifanicus), heavily exploited throughout Asia, are still relatively common in Qinghai Province's Baizha Forest. Even here, however, the economic incentive to acquire musk for selling on the black market is high. Musk deer are protected best near Tibetan Buddhist monasteries, where local people eschew killing, in deference to their revered lamas.

Photo by Cai Guiquan

In early June, USFWS and Nebraska Game and Parks personnel conduct a comprehensive survey of Least Tern and Piping Plover nesting areas along the Lower Platte River. Airboats provide the most efficient means of locating and accessing sandbar nesting sites. A greater number of terns and plovers nest on sandbars than on sandpits whenever there is habitat available on the River.

Photo by John Sidle

ANNUAL REPORT

of the

# MONTANA COOPERATIVE WILDLIFE RESEARCH UNIT

University of Montana
Missoula, Montana

to

THE UNIVERSITY OF MONTANA

MONTANA DEPARTMENT OF FISH, WILDLIFE AND PARKS

WILDLIFE MANAGEMENT INSTITUTE

U.S. FISH AND WILDLIFE SERVICE, DEPARTMENT OF THE INTERIOR

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Respectfully submitted,

Bart W. O'Gara, Leader

Joe Ball, Ass't. Leader

Male Chiltan markhors (Capra falconeri chiltanensis) in Hazarganji-Chiltan National Park, Balochistan, Pakistan. The creation of this national park saved this species from extinction.

Photo by the National Park Staff

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# MONTANA COOPERATIVE WILDLIFE RESEARCH UNIT PERSONNEL

## Coordinating Committee

Don Childress, Montana Department of Fish, Wildlife and Parks, Helena
Andrew Sheldon, University of Montana, Missoula
Bart W. O'Gara, U.S. Fish and Wildlife Service, Missoula

## Unit Staff

Bart W. O'Gara, Unit Leader
Joe Ball, Assistant Leader
Kerry Foresman, Division of Biological Sciences
Donald A. Jenni, Division of Biological Sciences
Zhenkui Ma, Postdoctoral Scholar
Les Marcum, Forestry School
Lee Metzgar, Division of Biological Sciences
Dan Pletscher, Forestry School
Robert R. Ream, Forestry School
Roland L. Redmond, Division of Biological Sciences
Andrew L. Sheldon, Division of Biological Sciences
Richard Taber, Forestry School
"Ginger" Schwarz, Office Manager
Virginia Johnston, Secretary

## Graduate Students

Tsui-lan Chen
Sherry Eisner
David Felley
Kurt Forman
Salah Hakim
Nathan Hall
Rich Harris
Eileen Kirsch
Victoria Kurnat
Yongsheng Liu
Ton Maeder
Jeff Marks
Dan Miller
Denise Pengeroth
Alison Perkins
Jon Rachael
Dave Reiner
Kevin Roy
Mark Secord
Kim Sutherland
Bill Swaney
Tim Van Deelen
Anne Vandehey
Amjad Virk
Amy Waller

## COOPERATING AGENCIES

Fish and Wildlife Service
Montana Department of Fish, Wildlife and Parks
University of Montana
Wildlife Management Institute

Balochistan Department of Forestry
British Columbia Ministry of Forests
Battelle, Pacific Northwest Laboratories
Confederated Salish and Kootenai Tribes
Ducks Unlimited
Government of Pakistan
IBM Corporation
Idaho Department of Fish & Game
Lee, Robert M.
Montana Department of State Lands
National Geographic Society
Nebraska Game and Parks Commission
Northwest College and University Association for Science
Northwest Plateau Institute of Biology, Xining, People's Republic of China
Plum Creek Timber Company
Qinghai Department of Wildlife Management, People's Republic of China
The Wildlife Society, Montana Chapter
U.S. Agency for International Development (USAID)
U.S. Department of Energy
U.S. Fish and Wildlife Service
  Alaska Fish and Wildlife Research Center
  Charles M. Russell NWR
  Cooperative Research Units Center
  Division of Refuges, Region 4 and Region 6
  Fish & Wildlife Enhancement, Region 6
  Grizzly Bear Recovery Coordinator's Office
  Lee Metcalf NWR
  Migratory Bird Management Office
  National Bison Range
  Northern Prairie Wildlife Research Center
  Pacific/Hawaiian Islands NWR
  Prairie Pothole Joint Venture
U.S. Forest Service
  Flathead, Kaniksu, Kootenai, and Lolo national forests
U.S. National Park Service
  Glacier National Park
U.S. National Zoo's Conservation & Research Center
Worldwide Fund for Nature (WWF)
World Wildlife Fund--U.S.

## PERSONNEL NOTES

Honors and Awards Received by Unit Staff and Students

| Award/Honor Received | Recipient | Reason |
|---|---|---|
| Bertha Morton Award | Richard Harris<br>Unit Student | Outstanding graduate scholastic achievement |
| George Bright Memorial Fellowship | Thomas Maeder<br>Unit Student | Outstanding graduate scholastic achievement in School of Forestry |
| Paul A. Stewart Award | Jeffrey Marks<br>Unit Student | Ornithological research |
| Hawaii Audubon Society Research Award | Jeffrey Marks<br>Unit Student | Ornithological research |
| Danny On Memorial Scholarship | Jon Rachael | Excellence in wildlife photography |

The following personnel joined the Unit on nongraduate student appointments of varying length:

Canada Duck Banding and NPWRC Prairie Duck Production

John Hughes
Douglas Johnson
Shawne Leasure
Karen Mullen
Scott Peterson
Lonnie Quinlan
Paul Sweet

YCC and Work Study Students

Billie Jo Cochran
Ronda Leathers
Norman Merz
Gene Miller
Fred Sargeson
Georgann Zachary

Other Field Studies

Gerald Altermatt (V-S)
Dan Breneman (V-S)
Douglas Brimeyer (V)
Nancy Heller (V-S)
Steve Hentschel (V-S)
Michael Lahti (V-S)
Shawne Leasure (V-S)
Frank McLaughlin (V-S)
Tim Obritschkewitsch (V-S)
Wilma O'Gara (V)
Don Shepard
Warren Tomkiewicz (V-S)
Rachel White
Barbara Warlick (V-S)
Wendy Wilson (V-S)
David Worthington (V-S)

(V) = Volunteer without subsistance allowance.
(V-S) = Volunteer with subsistance allowance.
All others are paid positions.

An otherwise good year at the Montana Unit was saddened by the untimely death of Kevin Roy. Kevin had just completed his master's degree and was working at his first job tracking grizzly bears in the wild areas south and east of Yellowstone National Park. His plane was apparently forced down in the wilderness during a sudden early blizzard. Search activities primarily by helicopters from Idaho, Montana, and Wyoming, along with as many as 300 searchers on the ground, continued for two weeks--the largest ground and air search in Wyoming history. A heavy snow probably obliterated all signs of the crash; it was with heavy hearts that searchers admitted defeat and discontinued the search.

Kevin and Vickie Kurnat Roy, another graduate student with the Montana Unit, were married 18 May 1991 and were looking forward to a joint career in the wildlife profession. Vickie is now working for the U.S. Fish and Wildlife Service, Bear River Migratory Bird Refuge, Brigham City, Utah.

Accepting the death of a friend or loved one is never easy, but to see a young man cut down at the beginning of a promising career is especially painful. Our sincerest sympathy to Vickie and Kevin's family.

Bart O'Gara
D. J. Ball
"Ginger" Schwarz
Virginia Johnston

A blood sample is taken from a hen pheasant to ascertain general condition of the hen and to test for mycoplasma gallisepticum--a disease that may be limiting pheasant reproduction.

Photo by R. Rickers

## ABSTRACTS

Bald Eagles Wintering along the Columbia River in Southcentral Washington: Factors Influencing Distribution and Characteristics of Perch and Roost Trees

Project Leaders: J. Ball and R. McClelland
Student: S. Eisner
Cooperators: Northwest College and University Association for Science; U.S. Department of Energy; Battelle, Pacific Northwest Labs

Results:

Bald eagles (Haliaeetus leucocephalus) wintering along the Columbia River in the shrub-steppe ecoregion of southcentral Washington were studied January-March 1986 and October 1986-March 1987. Study objectives were to quantitatively determine the influence of food, perch sites, and human activity on distribution, and to quantify and compare characteristics of perch, roost, and unused trees.

Bald eagles were nonrandomly distributed in 86 of the 136 1-km segments of the Columbia River in southcentral Washington. Most eagle observations (504/681 or 74%) occurred on the mid-Hanford Reach (47 river km); 21% were along Priest Rapids Dam Reservoir (28 river km), which was used January-March. Only 25 of 86 km were used frequently ($\bar{x}$ = 2.5 eagles/km). Distribution factors in the 86 used km were significantly discriminated from the 50 unused km. Eagle distribution was influenced by human activity (numbers of people, boats, and vehicles) and perch sites (characteristics of islands and riverbanks), but apparently not by abundance of food [Chinook salmon (Oncorhynchus tshawytscha), American coots (Fulica americana), and waterfowl]. Results of the analysis suggested critical factors were missing, possibly diets, foraging strategies, age-class, social bonding, or historical use-patterns.

Ninety-four percent of the bald eagles observed on the Hanford Reach were <300 m from the Columbia River using 10% (217/2241) of the trees >13.0 cm diameter at breast height and 40% (60/152) of the available stands. Stands were used as both diurnal perches and nocturnal roosts. Only 11 of 69 perch stands had frequent (major) use (70% of perch observations); 3 of 30 roost stands had major, or communal, use (91% of roost observations). Nearly all tree and stand characteristics were significantly different between used and unused stands, major and minor perches, and major and minor roosts. In general, major perch and roost trees were the tallest, largest in diameter, and most open-crowned trees in the largest, but least dense, stands. Additionally, all major perches overlooked

consistently used ground perches and primary foraging areas. Most eagles (75%) roosted overnight in 12 of 84 regularly used trees in major roosts; these 12 trees were taller, larger, and more open-crowned than other trees. Roost stands were larger (area and number of trees) and less dense than all but 1 of the 152 available stands. Stand and structural characteristics of communal roost trees were possibly related to roost behavior. Routine human activity apparently did not influence tree use.

Habitat Selection and Productivity of Least Terns (Sterna antellarum) Along the Lower Platte River, Nebraska

Project Leader: L. Metzgar
Student: E. Kirsch
Cooperators: Nebraska Game & Parks Commission; USFWS: Northern Prairie Wildlife Research Center

Results:

Habitat selection and productivity of Least Terns were studied on the lower Platte River in Nebraska, where this endangered species nests on natural sandbar habitat and spoil sites created by gravel dredging adjacent to the river. Available habitats of both types were characterized and quantified using aerial videography (1989-1990), and habitat use was assessed from census data (1987-1990). Productivity, disturbance, and causes for mortality were determined. Population trend was assessed with a deterministic model using my estimates of productivity and estimates of post-fledging survival derived from band return data.

Terns used river sites with large midstream sandbars and a wide channel, and large spoil sites with large surface areas of water. Many such sites on both habitats were not used. On both habitats the number of sites and amount of sand available were estimated using discriminant function analysis of variables quantified from videos. Terns did not prefer one habitat over the other. Proportions of available sites used were greater on spoils than on the river. However, proportions of available sand used were similar on both habitats. Proportions of terns using each habitat reflected the proportions of each habitat available. Terns initiated nests concurrently on both habitats. Rates of colony site turn-over on both habitats were similar.

Productivity was similar on both habitats, but varied significantly among sites. Nesting success, fledging success, and fledglings per pair averaged 0.60, 0.25, and 0.50. Chick survival most influenced production of fledglings on both habitats. Egg and chick survival appeared density dependent on both habitats. Predation caused most egg and chick mortality on spoils and most chick mortality on sandbars. Flooding caused most egg mortality on sandbars. Path analysis revealed no strong or consistent

correlations among mortality, disturbance, density, and habitat variables for both habitats.

The model suggested population trend near zero ($r = -0.003$). However, r was most sensitive to post-fledging survival and these estimates were unreliable. Variation in model parameters further lowered r.

Habitat selection theory predicts that terns not prefer a habitat when habitats are equally suitable. However, such habitat selection may not lead to population persistence in disturbed systems. Habitat alteration adjacent to the river may have changed predator/prey interactions, and terns may be suffering increased predation that could lead to population decline. Alternatively, life history traits of terns may allow persistence in spite of a prevailing slow decline if productive years occasionally occur.

Least Tern productivity is very low on sandbars and sandpits primarily because of poor chick survival. Nesting, hatching, and fledging success varies among sites within habitats. Chick survival may be density dependent on sandpits but not sandbars.

Photo by Eileen Kirsch

## Duck Nest Success in Montana

Project Leader: J. Ball
Student: V. Kurnat
Cooperators: USFWS: Refuges, Region 6; National Bison Range; Metcalf NWR; C. M. Russell NWR

Results:

The fates of 884 ducks nests and 1,536 artificial nests were studied in 1989-1990 at 8 sites in Montana. Success of artificial nests and duck nests did not differ significantly ($\underline{\bar{x}}$ = 49% vs $\underline{\bar{x}}$ = 49%; $\underline{F}$ = 0.076, 1 df, $\underline{P}$ = 0.7846). The relationship between success of artificial and duck nests was linear and statistically significant ($R^2$ = 0.756, $\underline{P} < 0.0001$), but variation was substantial. Success did not differ significantly between scented and unscented artificial nests ($\underline{\bar{x}}$ = 49% vs $\underline{\bar{x}}$ = 50%; $\underline{F}$ = 0.038, 1 df, $\underline{P}$ = 0.8458). Artificial nests may be useful as an index to duck nest success on sites with high levels of success and low predator populations, or in documenting high predation levels on sites where adequate samples of duck nests are difficult to find. However, high variability limits the use of this technique to predict duck nest success.

I also compared the mean vegetation height and density (visual obstruction) and fates of duck nests and artificial nests. The mean visual obstruction measurements for duck nests were significantly higher than for randomly placed artificial nests ($\underline{\bar{x}}$ = 2.2 dm vs $\underline{\bar{x}}$ = 1.6 dm; $\underline{F}$ = 6.28, 1 df, $\underline{P}$ = 0.0179). However, duck nests were not more successful than artificial nests ($\underline{\bar{x}}$ = 49% vs $\underline{\bar{x}}$ = 49%; $\underline{F}$ = 0.076, 1 df, $\underline{P}$ = 0.7846). Duck nest density increased exponentially with nest success ($R^2$ = 0.725, $\underline{P} < 0.0001$) and was highest on predator removal sites. Dense vegetation did not appear to ensure high nest success for ducks. Providing dense nesting vegetation without regard for predator communities and populations may result in ecological traps as nesting hens concentrate in attractive but unsafe cover.

## Characteristics of a Striped Skunk Population in the Mission Valley, Montana

Project Leader: J. Ball and K. Foresman
Student: D. Pengeroth
Cooperator: USFWS: National Bison Range
Results:

This study was initiated in 1988 as a striped skunk (Mephitis mephitis) removal program to improve nest success of upland nesting waterfowl. I studied habitat, site, and population parameters of striped skunks, based on trapping data obtained March through July, 1988-1990. Age-specific reproductive rates were also determined. Estimated skunk density ranged from 3.6/km$^2$ in 1988 to 2.7/km$^2$ in 1989, and 1.2/km$^2$ in 1990. Forty-nine males and 60 females were caught in 1988, 39 males and 37 females in 1989, and 17 males and 17

females in 1990. Fifty-six percent of all skunks caught were 1-2 years old. Most skunks were caught before 16 May during all 3 years. Trapping success was high among dense nesting cover (DNC), cropland, and hayland habitats and culverts, roadsides, and irrigation ditch sites. Temperature and precipitation had no effect on trapping success.

Median implantation date was 31 March; 1-year olds bred later than 2- or 3-year olds during all 3 years. Mean number of embryos was 6.71 $\pm$ 0.34, range 1-14 among 52 female skunks. The reproductive rate in 1988 was slightly higher than 1989 and 1990. There were no significant differences in reproductive rates among ages. Seventy-five percent of females were pregnant (including lactating females): 77%, 80%, and 60% of 1-, 2-, and 3-year olds, respectively. Non-pregnant females were captured later in the trapping season than pregnant females. Weights of pregnant and non-pregnant females did not differ significantly. Management strategies for reducing skunk populations include reducing availability of human-associated sites such as culverts, irrigation ditches, and roadsides.

## Dispersal Patterns of Juvenile Beavers in Western Montana

Project Leader: D. Pletscher
Student: T. Van Deelen
Cooperators: Montana Department of Fish, Wildlife and Parks; Lolo National Forest

Results:

I studied the dispersal behavior of 2-year-old beavers (Castor canadensis) in montane habitat during 1989-1990. In the spring of 1989, 8 2-year-old beavers were live-trapped, implanted with radio-transmitters, and released at their point of capture in 4 selected western Montana drainages. To increase sample size, 8 additional 2-year-old beavers were live-trapped from nuisance colonies, implanted with radio-transmitters, and released into the 4 study areas. I followed the radioed animals throughout the spring and summer until settlement in the autumn. The distribution of movement classes of transplants differed significantly from those of the "natives" ($\chi^2$ = 75.6, $P < 0.0001$). Three of the 8 natives dispersed and all of the 8 transplants moved sufficiently to mimic dispersal.

In the spring of 1990, one of the 4 drainages (Fish Creek) was selected for more intensive study. Fourteen native 2-year-old beavers were implanted with radio-transmitters and followed until settlement late in the fall. Seven of these dispersed.

The movements of the 22 2-year-old native beavers separated into 3 patterns: 12 showed no dispersal, 5 showed dispersal with rapid settlement (within 16 days), and 5 showed dispersal with delayed settlement (35 to 181) days. The male:female ratio of dispersing 2-year olds (350:100) was higher (though not signifi-

cantly, $X^2 = 0.89$, $P = 0.42$) than that of non-dispersing 2-year olds (100:100) and 114 other-age-class beavers that were handled during this study (60:100).

Dispersal distance and dates of dispersal and settlement varied greatly between dispersers. Distance was not significantly correlated with date of dispersal ($P = 0.38$) or the magnitude of the dispersal-settlement interval ($P = 0.76$). Age-specific mortality estimates ($q_x$) for the 2-year-old age class were 0.31 in 1989 and 0.38 in 1990.

Low dispersal-aged mortality and delayed settlement suggest a subpopulation of transient beavers, unattached to traditional colonies, that may be important in maintaining the stability of the population. Managers should recognize that 1) population indices often do not account for transients, and 2) that dispersal behavior may determine the success of nuisance colony control and may help prevent over-exploitation.

## Vegetative Productivity of Selected Grizzly Bear Habitats in Southeastern British Columbia

Project Leaders: D. Bedunah and C. Servheen
Student: A. Vandehey
Cooperator: USFWS: Office of the Grizzly Bear Recovery Coordinator

Results:

Sampling techniques and strategies were developed for the estimation of biomass of seven grizzly bear (Ursus arctos) foods: Angelica arquta, Equisetum arvense, Erythronium grandiflorum, Hedysarum sulphurescens, Heracleum lanatum, Shepherdia canadensis, and Vaccinium globulare.

Methods were tested in nine habitat units in the North Fork of the Flathead River drainage in southeastern British Columbia. Sampling occurred during each food species season-of-use by grizzly bears. Net protein and energy per habitat unit were based on biomass estimates. Mean kg/ha of digestible protein and mean kcal/ha of digestible energy provided by the seven food species, and associated variances were reported. Identification of feasible methods was determined in relation to the sample sizes required to attain prescribed levels of confidence and sample error.

Methods determined to be feasible for estimating biomass were described for H. lanatum and S. canadensis. Methods that may be refined to produce suitable estimates were described for H. sulphurescens and V. globulare. Suitable methods for producing acceptable estimates of E. grandiflorum and A. arquta did not evolve during this research.

Based on biomass estimates of the four species for which acceptable methods were developed, habitats providing the most abundant sources of digestible protein were riparian components and avalanche chutes. Habitats providing the most abundant sources of digestible enerty were riparian components, V. globulare shrubfields, avalanche chutes, and S. canadensis shrubfields, respectively.

Management Plan for Wild Ungulates in Balochistan, Pakistan

Project Leader: B. O'Gara
Student: A. Virk
Cooperators: U.S. Agency for International Development (USAID); Government of Pakistan; Department of Forestry, Balochistan

Results:

Wild ungulate populations in Balochistan have been reduced to low numbers. Now, these subpopulations are confined to small isolated areas. Major wildlife conservation problems are administration, socio-economic, poaching, law enforcement, shortage of trained staff, lack of awareness, and politics.

The overall wildlife management goals in Balochistan should be protection, conservation, management, and sustainable utilization of wild ungulates. This should be accomplished through restoring the reduced populations, improving depleted habitats, strengthening conservation agencies, and creating awareness among masses. Communities in Balochistan are based on tribal systems, and goals of conservation cannot be achieved without active participation of tribal people. They should be involved through economic incentives and social benefits.

Detailed surveys are needed to determine the current distribution and population status of wild ungulates. Aerial surveys could be the best option, because mountain ranges in Balochistan are rugged and difficult to approach by road. Little is known about ecology of wild ungulates in the arid environment of the area. Ecological and biological studies of the ungulate species would be required to assess the management requirements for each species. The management of straight-horned markhor, chiltan markhor, wild goat, Balochistan urial, goitered gazelle, and chinkara should be aimed at building up their populations to provide controlled trophy hunting, meat hunting, and generation of funds for the conservation of wildlife in the Province. Proper management plans would be required for the management of national parks, wildlife sanctuaries, and game reserves. Supervisory staff are not available for the conservation of wildlife. A massive program would be necessary to develop trained manpower for the effective conservation of wild ungulates in the Province.

Seasonal Habitat Use of River Otters
in Northwestern Montana

Project Leader: L. Metzgar
Student: A. Waller
Cooperators: Montana Department of Fish, Wildlife and Parks
Results:

River otter (Lutra canadensis) habitat use and preferences were investigated in the Flathead River Valley. Habitat data were collected at occupied sites and random sites to characterize seasonal habitat use, determine seasonal habitat preferences (use-availability), and develop seasonal classification criteria. The greatest influence on river otter habitat use appeared to be the availability of cover.

Undercut banks, vegetation overhang, and emergent vegetation were present at the majority of occupied sites each season. The otters used areas having low to moderate bank heights and slopes. The ground cover consisted mainly of grasses, and the mean percent of understory cover ranged from 23-37% between seasons. Every season, occupied sites had significantly higher frequencies of beaver cuttings than random sites.

During winter, the otters preferred areas with larger undercuts, tree canopies, and beaver lodges or brush piles. Linear discriminant function analysis (DFA) of tree canopy, beaver lodge/brush pile, rock, bank slope, and undercut area correctly classified 77% of the winter cross-validation cases.

During spring, the otters preferred sites with flatter banks, less inland water, more instream woody debris, and beaver lodges or brush piles. Linear DFA of bank slope, vegetation overhang, inland water, beaver lodge/brush pile, and inland woody debris correctly classified 78% of the summer cross-validation cases.

Summer habitat preferences included more understory cover, more bank holes, longer vegetation overhang, more woody debris in the emergent areas, and beaver lodges or brush piles. Linear DFA of beaver lodge/brush pile, new beaver cuttings, emergent length, and understory cover correctly classified 71% of the summer cross-validation cases.

Fall habitat preferences included more bank holes, less bare ground, larger undercuts, flatter banks, and longer vegetation overhang. Linear DFA of old beaver cuttings, undercut area, understory cover, and total woody debris correctly classified 75% of the fall cross-validation cases.

The classification results of linear DFA and nonparametric K nearest neighbor DFA were not significantly different.

## COMPLETION REPORT

Alternative Management Strategies for Musk Deer in Qinghai Province, People's Republic of China

Project Leader: B. O'Gara
Student Investigator: R. Harris
Funding: Robert M. Lee; Northwest Plateau Institute of Biology, Xining, People's Republic of China; Worldwide Fund for Nature (WWF)

Results:

Aspects of the ecology of musk deer living in a forested portion of the Tibet-Qinghai Plateau were investigated during 1988-1990. A radio-collared subadult male used a home range of approximately 18 ha during November, preferring rock outcrops for daytime resting cover and forest-meadow edges for nighttime feeding. Incidental observations suggested that musk deer often produce twins in this area, although fawns are difficult to see until mid-October. Estimated density of musk deer was 2-3/$km^2$ of occupied habitat. Musk deer home ranges occur in second-growth forests and shrubfields lacking trees, suggesting that lack of virgin forest does not necessarily preclude occupance; however, the relatively low density and wary nature of musk deer suggests that human exploitation pressures on them remain high.

Musk deer in China, although provided with strong legal protection, are subject to varying levels of exploitation depending on the de facto conservation system operating in each locale. In southern Qinghai Province's Baizha Forest, musk deer have declined in most areas, due primarily to snaring by nonlocal people. However, musk deer, as well as blue sheep and white-lipped deer populations in close proximity to Tibetan Buddhist monasteries and some villages, are afforded protection from most poaching activities, although they still suffer incremental loss of habitat as human and livestock populations increase. An intermediate situation exists near a government-operated forestry guard station, where poaching by outsiders is deterred, but the guards themselves kill some wildlife. The existence of differing protection levels within an area where all wildlife exploitation is nominally proscribed suggests that local cultural practice and economic contingencies are more important than legal sanctions alone.

Local Tibetan people were hired to assist in capturing musk deer (Moschus sifanicus) for study. This not only made capture operations more efficient, but also provided an opportunity to determine their attitudes toward local wildlife.

Photo by R. B. Harris

## STUDENT RESEARCH PROJECTS

Status and Demography of the Bristle-thighed Curlew

Project Leaders: R. Redmond and J. Ball

Student Investigator: J. Marks

Cooperators: USFWS: Pacific/Hawaiian Islands NWR and Alaska Fish and Wildlife Research Center; National Geographic Society; World Wildlife Fund

Objectives:

1. Describe molt by age class, including timing, duration, and pattern of feather replacement;
2. describe molt-induced flightlessness, including duration of the flightless period and habitat use during flightlessness, and estimate the proportion of adults that becomes flightless;
3. determine whether curlews molt remiges twice during the nonbreeding season, and, if so, determine whether they become flightless during the second molt;
4. assess the influence of sunlight (i.e., UV radiation) on the fading and wear of curlew primaries;
5. determine the timing of spring and autumn migration and describe migratory behavior;
6. determine if Laysan is a major stopover for migrating curlews and whether curlews spend the winter on Laysan after completing molt there in autumn;
7. determine annual survivorship by age class and age of first breeding; and
8. determine spatial use patterns (i.e., territoriality and home range use) by age class and among years.

Results:

The 1990 field season occurred from mid-August to late November. During this period Marks and M. Burcham banded 66 new curlews and recaptured 33 birds marked previously. An average of 100.4 curlews (SD = 23.4, range = 66-127) was observed during 30 island-wide censuses. Based on mark-resighting indices, about 300 curlews resided on Laysan during autumn.

Timing of molt was similar to that documented previously; most adults began primary molt in mid- to late August and completed molt from mid-November to mid-December. Eight curlews were captured in a

state of molt-induced flightlessness. Six were caught by hand during the day and 2 were netted at night and fitted with radio transmitters to confirm that the birds could not fly. Owing to artificially large losses in mass (and subsequent slowing of molt) after radio instrumentation, none of the 13 curlews radio-tagged prior to molt became flightless. The proportion of adults that becomes flightless will be estimated September through November. (Flightless birds behave in a manner that makes them easily distinguishable during daylight. Adults "disappearing" for 2-3 weeks during October or November and then reappearing later will be considered to have been flightless.)

We observed 155 curlews that had been uniquely marked on Laysan in 1988 or 1989, including 46 of 59 (78%) marked in 1989 and 104 of 125 (83.2%) marked in 1988 and resighted in 1989. Considering curlews marked in 1989, we resighted 90% of the second-year (SY) birds (9 of 10), 84.6% of the third-year (TY) birds (11 of 13), and 72.2% of the adults (26 of 36). We also resighted 4 curlews marked in 1988 but not seen in 1989. Clearly, the resightings underestimate annual survivorship.

The 1991 field season, which was Marks' fifth and final expedition to Laysan, occurred from early February to mid-June. Emphasis was on observing marked birds and monitoring northward migration. Thus, Marks and S. Leasure caught only 7 new curlews and recaptured 21 that had been marked previously. An average of 95.6 curlews (SD = 14.0, range = 68-126) was observed during 24 censuses conducted before spring migration. Based on mark-resighting indices, about 290 curlews resided on Laysan during winter. Nearly 97% of the 213 marked curlews seen during autumn 1990 were still on the island between February and May 1991, confirming that curlews arriving on Laysan during southward (autumn) migration also spend the winter there.

Contrary to previous belief, adult curlews do not molt their flight feathers twice each year. The prealternate molt that occurs in winter is restricted to the body feathers and some rectrices (especially the central pair of rectrices). The appearance of bright, seemingly unworn primaries in spring probably results from their low exposure to sunlight: when the wings are folded, the primaries are almost completely covered by the tertials, and the intensity of sunlight is much reduced in winter owing to lots of cloudy days and the sun's low angle. SY birds did not begin molting their juvenile primaries until about mid-March, confirming my earlier belief that hatching-year birds arrive in Hawaii with remiges that will not be replaced until birds are in their second year.

Beginning in the last week of April, curlew flock sizes at diurnal roosting sites increased substantially, and many birds began flying around the island in small, vocal flocks. Flocks also began to visit the staging area at the northern tip of the island. These were signals that migration was "in the air." We observed 17 northward departures between 1 and 13 May, with the peak of migration occurring during the first week of May. Few (if any) curlews migrated before 28 April or after 15 May. Flock sizes at the staging area ranged from 1-48 birds, and the actual number of birds leaving the island ranged from 1-22 per flock. Most departures occurred between 1000 and 1400 hours. Subadults (i.e., SY's and TY's) accompanied migrating flocks

at the staging area, often departing with the flocks only to return to the island the same or the next day. Subadults were noticeably thinner than adults and presumably were not in good enough condition to complete a trip to Alaska. These observations confirmed that bristle-thighed curlews do not attempt to breed until at least their 4th year (at about 34 months of age). We also determined that a few individuals over-summer on the wintering grounds until they are in their 5th or 6th year.

Ratios of marked to unmarked birds at diurnal roosts before and during migration suggested that Laysan is not a major stopover for migrating curlews during spring. Past work documented that the same is true during autumn migration. Thus, curlews wintering in the South Pacific probably migrate huge distances nonstop between their breeding and wintering grounds twice each year.

Three adults collected at the staging area during the peak of migration have been sent to the Gaylord Memorial Laboratory at the University of Missouri for analysis of fat content. We plan to make a brief visit to Midway Atoll (620 km NW of Laysan) this spring to collect several more adults to assess fat content.

## Movements, Activity Patterns, and Body Temperature Regimes of Reintroduced Fishers in the Cabinet Mountains of Montana

Project Leader: K. Foresman

Student Investigator: K. Sutherland

Cooperators: Montana Department of Fish, Wildlife and Parks; USFS: Kootenai National Forest; The Wildlife Society, Montana Chapter

Objectives:

1. Determine the short-term success of the effort to reestablish fishers in the Kootenai National Forest;
2. examine the effectiveness of soft release vs. hard release procedures in translocating fishers;
3. document dispersal rates and distances;
4. evaluate habitat use to examine habitat needs for dispersal and home range (central tendency) establishment; and
5. examine the possibility of facultative body temperature regulation in fishers as an energy conserving tactic.

Results:

Seventy-eight fishers were released into the Cabinet Mountains of northwestern Montana between October 1990 and October 1991. All were live-trapped in Wisconsin and transported to Montana via covered truck. Thirty-eight and 40 fishers were released into the Cabinet

Mountains in 1990 and 1991, respectively. In 1990, 24 of the animals were radiotagged (5 surgically implanted with temperature-sensitive transmitters and 19 fitted with collars). Of these, 12 were soft-released and 12 were hard-released to examine the effect of release techniques on movements and survival. All of the untelemetered animals from 1990 and 1991 were hard-released.

The 24 radiotagged fishers, as well as 2 to 7 collared fishers from a previous release (1989) were located from the ground or from fixed-wing aircraft every 2-5 days from October 1990 through September 1991. Additionally, the 1989 fishers had been monitored since June 1990. The locations will be used to examine movements and habitat use. Twenty-four hour remote activity monitoring conducted throughout the field season will provide data on daily activity patterns and body temperature regimes (for the implanted animals). Data analysis and write up is expected to be completed by June 1992.

Estimating the Nutritional Quality of
Bear Habitat in Southeastern British Columbia
by Measuring Bear Body Condition

Project Leader: C. Servheen

Student Investigator: D. Reiner

Cooperators: USFWS; British Columbia Ministry of Forests

Objective:

Measure the nutritional quality of different bear habitats by measuring changes in the body condition (body weight and fat composition) of intensively tracked, radio-collared bears as they use different habitats.

Results:

Both black bears and grizzly bears will be captured using conventional techniques. They will be fitted with recapture collars (Wildlink Inc.). Radiolocations will be investigated and vegetative plots will be conducted when bear sign is found. Bears will be recaptured approximately every 2 weeks. They will be weighed and have their fat composition measured using a bioelectrical impedance meter at each recapture.

The student has just completed the first field season and is currently taking classes.

Mortality of White-tailed Deer in an Area Recently Recolonized by Wolves

Project Leader: D. Pletscher

Student Investigator: J. Rachael

Cooperators: USFWS: Region 6 Fish & Wildlife Enhancement; British Columbia Wildlife Branch; USFS: Flathead National Forest; NPS: Glacier National Park; and Montana Department of Fish, Wildlife Parks

Objectives:

1. Evaluate cause-specific mortality of white-tailed deer within the area recolonized by wolves;
2. describe seasonal distribution of white-tailed deer, including migration patterns and key areas of seasonal use;
3. select techniques and initiate sampling strategy to develop an index of deer abundance;
4. determine age and sex structure of white-tailed deer population; and
5. determine important habitat characteristics of areas used for fawning.

Results:

We captured and radio-collared 38 female white-tailed deer in winters 1989-1990, and 1990-1991. Wolves, bears, mountain lions, coyotes, and humans each killed 2 collared deer. Estimated annual survival rate was 0.725 (95% CL = 0.577-0.877). Survival was highest during summer (100%) and autumn (94.9%), and lowest during spring (85.9%) and winter (89.0%). Annual cause-specific mortality rates ranged from 3.6% (bears) to 5.7% (humans), but 95% confidence limits from all mortality sources overlapped significantly. Annual mortality of deer from mountain lions was 5.5%, while mortality from both wolf and coyote predation was 4.6%.

Deer wintered in 4 major areas in the North Fork Valley: Kintla Lake, confluence Kintla Creek/North Fork Flathead river-bottom, Polebridge/Bowman Creek, and the Sullivan Meadow area. Between early April and mid-June, radio-collared females migrated an average of 12 km (SD = 10.7, range = 0 - 40 km) to summer range. Twenty-seven of 30 deer summered in the main valley bottom; only 3 spent summers in side drainages.

A population monitoring index has been initiated, the sex and age structure of the population has been estimated, and habitat sampling of fawning areas is complete. Data analysis and thesis preparation are underway.

Options for Wildlife Conservation in Wild Yak Valley, Qinghai Province, People's Republic of China

Project Leader: B. O'Gara

Student Investigator: R. Harris

Cooperators: Robert M. Lee; Northwest Plateau Institute of Biology, Xining, People's Republic of China; Worldwide Fund for Nature (WWF)

Objectives:

1. Estimate densities of the seven wild ungulate species inhabiting Wild Yak Valley;
2. determine habitat and food preferences of the seven ungulate species;
3. delineate the major obstacles to effective conservation of these and other species in Wild Yak Valley; and
4. investigate the feasibility of generating funding from foreign sources to aid in conservation in Wild Yak Valley.

Results:

Wildlife surveys were conducted in Wild Yak Valley from 11 July to 13 August, and from 15 September to 8 October 1991. Mapped locations were recorded for sightings of wild yak (Bos mutus), Tibetan wild ass (Equus hemionus), Tibetan gazelle (Procapra picticaudata), Tibetan antelope (Pantholops hodgsoni), blue sheep (Pseudois nayaur), argali (Ovis ammon), and white-lipped deer (Cervus albirostris). Twenty-six collections of fecal material were made to represent food habits of the seven species in definable habitats. Fragment analyses of these samples is currently ongoing. Discrete herds of blue sheep and argali, and relatively discrete assemblages of wild yaks were delineated. Yaks numbered at least 1,000; preliminary estimates of blue sheep and argali numbers were about 900 in eleven bands and 240 in six bands, respectively. To estimate density of Tibetan gazelle, Tibetan antelope, and Tibetan wild ass, 32 census units were delineated with randomly placed line transects, and 28 of these were successfully surveyed. Detailed analyses of census data is continuing.

Survey research on the potential for generating conservation funding through nature travel and/or trophy hunting is continuing. A second and final field season is planned for August/September 1992.

Seasonal Range and Habitat Selection by White-tailed Deer in Northwestern Virginia

Project Leader: B. O'Gara

Student Investigator: S. Hakim

Cooperators: National Zoo's Conservation and Research Center, Front Royal, Virginia

Objectives:

1. Determine seasonal home-range size and distribution relative to habitat;
2. compare seasonal habitat selection of deer;
3. identify variables that influence such selection and look at seasonal changes;
4. determine if seasonal activity patterns are related to home range size or forage availability;
5. describe family interactions and group size; and
6. estimate population structure.

Results:

The student has submitted the first draft of his dissertation.

Movements and Ecology of Wild Yaks in Qinghai Province, People's Republic of China

Project Leader: B. O'Gara

Student Investigator: D. Miller

Cooperators: Robert M. Lee; Northwest Plateau Institute of Biology, Xining, People's Republic of China

Objectives:

1. Classify vegetal and structural characteristics of wild yak habitat in Qinghai Province.
2. determine population characteristics (density, movements, sex ratio, age structure) for wild yaks in the intensive study area;
3. determine seasonal habitat selection and use, seasonal food habits, and activity patterns for wild yaks;
4. assess range condition trends and competition between wild yaks and domestic livestock for forage.

Results:

The student just completed a field season in China. Landsat 5 Thematic Mapper Imagery for the study area was acquired in Beijing and a false color composite image has been prepared. Image processing is being conducted to develop a computer-generated vegetation classification of vegetation and wildlife habitat of the study area. Numerous reports and papers are being prepared. The student has taken a short-term assignment with the World Bank on a forestry development project in Bhutan; he will be taking courses on campus winter quarter 1992.

Ring-necked Pheasant Recruitment and Survival in Southwestern Idaho

Project Leader: J. Ball

Student Investigator: D. Felley

Cooperator: Idaho Department of Fish and Game

Objectives:

1. Estimate hen survival;
2. estimate hen success rate;
3. estimate brood survival;
4. integrate information from objectives 1, 2, and 3 to produce a simple recruitment model;
5. describe the habitat types used for nesting and brood rearing, and describe the relationship between habitat and recruitment;
6. describe the phenology of crop growth and harvest and relate it to the phenology of nesting and brood rearing; and
7. identify mortality factors limiting pheasant populations.

Results:

A recruitment study of a ring-necked pheasants (Phasianus colchicus) in Canyon County, Idaho was initiated in February 1990. Fifty-two hens were caught and radio-collared in the winter of 1991. These hens and an additional 5 from the 1990 field season were followed through spring dispersal, nesting, and brood-rearing periods. Data were collected on hen survival, nest success, and brood survival to develop a recruitment model of the population. Initial results estimate fall recruitment to be 0.741 juvenile hens for each hen entering the breeding season. Better survival estimates are needed to fully evaluate population trends. Data were collected on nest success in relation to nest site selection and habitat availability. Early nest attempts in grain were most successful, producing more broods than any other cover type.

Pheasant Recruitment and Survival in Southcentral Idaho

Project Leader: J. Ball

Student Investigator: T. Maeder

Cooperators: Idaho Department of Fish and Game

Objectives:

1. Evaluate pheasant recruitment in southcentral Idaho;
2. estimate survival of hen pheasants during the spring-summer reproductive period;
3. integrate information from objectives 1 and 2 to produce a simple recruitment model;
4. evaluate recruitment and survival of wild introduced pheasants compared to indigenous pheasants;
5. describe the vegetative types used by nesting and brooding pheasants, and the relationship between habitat and recruitment; and
6. identify mortality factors limiting pheasant populations in southcentral Idaho.

Results:

Forty-eight radio-collared hens were followed through spring dispersal, nesting, and brood-rearing. Twenty-eight were local hens and 20 were transplanted wild hens. Data were collected on hen survival, nest success, and brood survival to develop a recruitment model for the population. Overall hen survival for the monitoring period was 0.452. The main causes and times for hen mortality were by predation just after release and during the spring dispersal period, and by swathing during nest incubation. Canine predation was the most common type of predation. Total nest success for the reproductive period was 32% and hen success was 54%. A recruitment model indicated an increase of 8% in the population. Local hens had twice the survival rate of transplanted hens. Tranplanted hens were two times more likely to hatch a nest than local hens.

White-tailed Deer/Forest Management
Relationships in Northern Idaho

Project Leader: D. Pletscher

Student Investigators: M. Secord

Cooperators: Idaho Department of Fish and Game; Kaniksu National Forest

Objectives:

1. Identify, describe, and provide management recommendations for winter range habitats;
2. test logistic regression models developed by Idaho Department of Fish and Game for predicting white-tailed selection of deer timber stands from snow depth;
3. describe the structural and vegetative characteristics of various cutting units in the cedar/hemlock zone of northern Idaho, and correlate these characteristics with white-tailed deer use during spring and summer.

Results:

During January through March 1991, 5 male and 11 female white-tailed deer were radio collared on the west side of Priest Lake. As of 1 October 1991, 4 males and 1 female have been taken by predators, and 1 female has been killed by a vehicle. Three of the predator-related losses were confirmed mountain lion (Felis concolor) kills.

Between 12 January and 1 April 1991, 120 ground relocations were obtained on the winter range. Relocations were predominately in dense stands of pole and mature timber of the western red cedar and western hemlock series. Study animals remained below 920 m in elevation and were located in timbered areas adjacent to Priest Lake throughout the study period. The majority of relocations were on southern aspects.

A data set independent of that used to develop the stand structure prediction model is still being compiled. Preliminary results have shown model predictions to be invalid.

Pellet group counts have been initiated in 12 clearcuts in the Priest Lake region. Measurements of the vegetative structure and composition of each unit are also underway.

Data collection will be completed by September 1992, with project completion set for June 1993.

A Survey of International Hunting and Its Local Involvement, Qinghai, Peoples Republic of China

Project Leader: B. O'Gara

Student Investigator: Y. Liu

Cooperator: Robert M. Lee; NW Plateau Institute of Biology, Chinese Academy of Sciences, PRC; Bureau of Wildlife Management, Qinghai, PRC

Objectives:

1. Investigate the decision-making process that led to the establishment of Dulan International Hunting Area;
2. describe the attitudes of local people toward the international hunting program;
3. evaluate the strategy of using international hunting for economic incentives to wildlife management in Qinghai Province.

Results:

The original proposed project for this master's program was "Behavior of Blue Sheep (Pseudois nayaur) During the Rut." This was abandoned because of logistic problems.

The first field season inventory was implemented from 10 July through 11 September 1991. The goal of the first season was to collect baseline information and obtain a general feeling of the circumstances of the study area. Open-ended questionnaires were used in the field to probe baseline information, such as: what kind of programs are currently going on in the international hunting area? Do these management programs receive local support? What are the main problems in international hunting management? The data gathered will help to shape the method for second field season during summer 1992.

International hunting in Qinghai, started in the mid-1980's, is gaining support from wildlife agencies as well as from local society. In most of China's designated wildlife reserves, financial shortage is the main problem for implementation of necessary conservation programs. The great monetary benefit from the international hunting program is the driving force that attracts wildlife management decision makers. Nonlocal poaching is nearly uncontrollable on a provincial scale and is the main factor that brought certain species, such as musk deer and brown bear, to extinction in most of their habitat in the Province. Lack of manpower in wildlife management agencies has excluded the possibility of removing nonlocal human pressure from some wildlife reserves. This has made local involvement in these wildlife reserves very important. The International Hunting Program in Dulan has provided local residents substantial extra income and has made local people interested in being involved in wildlife conservation programs.

Nest Success of Upland-Nesting Ducks
in the Flathead Valley

Project Leader: J. Ball

Student Investigator: N. Hall

Cooperators: USFWS: National Bison Range; Montana Department of Fish, Wildlife and Parks

Objectives:

1. Document nest success and, where possible, causes of nest failure on both removal and nonremoval areas;
2. evaluate costs and benefits of skunk removal;
3. attempt to quantify the relative importance of pair habitat; size, type, and condition of cover; and the presence or absence of predators; and
4. submit management recommentations.

Results:

The student investigator is preparing his thesis.

Effects of Nest Predators on Ground-nesting
Bird Communities in Northwest Montana

Project Leader: D. Pletscher

Student Investigator: W. Swaney

Cooperators: USFWS: CRUC, R-6, and PPJV; Confederated Salish & Kootenai Tribes; Ducks Unlimited

Objectives:

1. Describe distribution, abundance, and species composition of nesting bird communities relative to habitat type and cover density; and
2. quantify nest success of the most common nonwaterfowl bird species in relation to habitat quality and predator populations.

Results:

Totals of 89 (0.1/acre) and 13 (0.03/acre) nests were found in the removal and control areas. Species included western meadowlark (31), short-eared owl (27), common snipe (11), ring-necked pheasant (9), killdeer (8), Wilson's phalarope (6), savannah sparrow (4), spotted sandpiper (2), vesper sparrow (2), northern harrier (1), and American avocet (1).

Mayfield estimates of nest success on the removal area were 49% for western meadowlarks and 21% for short-eared owls, although sample sizes were too low to allow precise estimates. For some species (i.e., meadowlarks, pheasants, and sparrows), it became obvious that we were unable to find many of the nests that were present and also that the proportion of nests found probably varied with cover density. Analyses of the number of birds flushed to the number of nests found are being conducted, and that part of the project will receive more emphasis in 1992. In addition, dummy nests will be used in 1992 to evaluate nest success.

## Influence of Skunk Removal on Nest Success and Breeding Pair Densities of Upland-Nesting Ducks in the Lower Flathead Valley

Project Leader: J. Ball

Student Investigator: K. Forman

Cooperators: USFWS: National Bison Range, Region 6, U.S. Prairie Pothole Joint Venture; Montana Department of Fish, Wildlife and Parks; Confederated Salish and Kootenai Tribes; Ducks Unlimited

Objectives:

1. Continue to monitor duck nest success and densities on control and removal areas;
2. assess the relative importance of land use, predator populations, and the height-density component of nesting cover as determinants of nest densities and success;
3. quantify breeding pair densities in relation to wetland type and land use within the removal area; and
4. survey predator community composition and relative abundance throughout the entire lower Flathead Valley.

Results:

As part of an ongoing waterfowl predation study, 26 striped skunks were removed from the 50-km$^2$ Ninepipe study area during 6,025 trap-nights between 20 March and 2 July. Although trapping effort has essentially remained constant among years, this represents a continued decline in the number of captures: 1990 ($n$ = 32), 1989 ($n$ = 77), and 1988 ($n$ = 109).

Three nest searches were conducted between 25 April and 3 July on 355 ha within the Ninepipe skunk removal area; 105 ha were searched during the same period at the Pablo National Wildlife Refuge (control area). A total of 279 usable nests located on the removal area yielded a Mayfield nest success of 24.5% (95% CI 19.5-30.9%), which is marginally greater ($Z$ = 1.84, 0.10 > $P$ > 0.05) than the Mayfield of 10.0% (95% CI 4.7-21.0%) derived from a 52-nest sample at Pablo. Apparent nest densities on the removal area ranged from 2.22/ha in a

29-ha plot of seeded nesting cover to 0.08/ha in 50 ha of heavily grazed pasture.

Breeding duck populations were surveyed on 100 randomly selected wetland basins on State, Federal, or Tribal land within the removal area. A total of 295 indicated breeding pairs were surveyed on 91 "wet" basins, and dabbling duck densities reached 11.0 pairs/wetland ha. Data collection will resume in spring 1992.

Nesting and Brooding Ecology of Waterfowl at Freezeout Lake Waterfowl Management Area

Project Leader: J. Ball

Student Investigator: A. Perkins

Cooperators: USFWS: Fish & Wildlife Enhancement; Montana Department of Fish, Wildlife and Parks

Objectives:

1. Develop a detailed and accurate habitat map of Freezeout Lake WMA;
2. describe nest distribution, nest success, and egg success of ducks and associated ground-nesting birds at Freezeout;
3. determine whether nest density and nest success differ by habitat type or distance from water; and
4. investigate distribution of duck broods and, if possible, duckling survival.

Results:

Wetland drainage, cultivation and fragmentation of grasslands, and overgrazing are obvious negative impacts of agriculture on waterfowl and other ground-nesting birds. Irrigation drainwater, however, is used in many areas to supplement water supplies to wetland complexes. Unfortunately, dangerously high concentrations of selenium that could cause severe reproductive abnormalities in aquatic birds were discovered in wetlands associated with irrigation drainwater in California. Concern for contamination in other areas prompted reconnaissance investigations of numerous irrigation projects throughout the United States. These investigations showed a potential for contaminants to affect fish and wildlife resources in the Sun River Irrigation Project (SRIP) in Montana. Baseline nesting information from Freezeout Lake WMA, part of the SRIP, is therefore necessary to determine the potential effects contaminants may have on waterfowl populations in the area.

Field work at Freezeout began on 22 May and continued through 26 July 1991. A broad variety of nesting habitats were examined including native prairie, planted dense nesting cover, and wetland vegetation. A total of 325 nests was located, of which 71% were waterfowl nests. Few nests of mallards and pintails, two species whose continental populations have been declining since the early 1980's, were located.

## SPECIAL PROJECTS

Physiologic and Ecological Studies of the Pronghorn (Antilocapra americana)

Project Leader: B. O'Gara

Cooperators: USFWS: National Bison Range; Montana Department of Fish, Wildlife and Parks; and the Wildlife Management Institute

Objectives:

To study:

1. the reproductive physiology of male and female pronghorn;
2. the physiology and function of scent glands;
3. food habits related to changes in range conditons;
4. horn growth and casting; and
5. the relationships of pronghorns to other artiodactyls.

Results:

Twelve book chapters are in press, but the editor has requested another on pronghorns in the 21st century. A new set of guidelines for management of pronghorns is being prepared for presentation at the Pronghorn Antelope Workshop in Wyoming during spring 1992.

Duck Banding in Canada

Project Leader: J. Ball

Student Technicians: Varies, 4 to 6 annually

Cooperator: USFWS: Migratory Bird Management Office

Objectives:

1. Trap and band 2,000 mallards and up to 1,500 pintails and 1,000 of each of the other species available. This quota will be sought at each of 10 banding stations;
2. maintain accurate records and provide summary reports from each station to the Migratory Bird Management Office;
3. provide students from the Montana Cooperative Wildlife Research Unit with training in waterfowl research techniques and an ecological perspective that can only be obtained through on-the-ground experience; and
4. evaluate distribution of recoveries, recovery rates, and (when possible) survival rates of northern shovelers and gadwalls.

Results:

Vary annually. Detailed annual reports are available. Preliminary analyses of shoveler and gadwall files have been completed.

Identification and Protection of Biodiversity in Montana Using a Geographic Information System

Project Leader: R. Redmond

Cooperators: USFWS: Cooperative Research Units Center; IBM Corporation

Objectives:

1. Develop an expert systems model to predict vegetation and land cover classes from Landsat thematic mapper (TM) imagery and biophysical data;
2. use the model to classify and map the state's vegetation and land cover at a scale of 1:250K for uplands and 1:100K for wetlands;
3. predict and map the distributions of native terrestrial vertebrates;
4. map the boundaries of all protected lands in the state according to administrative organization and level of protection;
5. assess accuracy of procedures and products; and
6. conduct GIS analyses to identify vegetation types and areas of high species richness that may lack adequate protection under current land ownership and management regimes.

Results:

A Research Work Order with the University of Montana went into effect on 1 May 1991. A considerable amount of time since then has been devoted to promotion of the project and negotiations with potential cooperators. These include the Forest Service, Bureau of Land Management, National Park Service, Bureau of Indian Affairs, Montana Department of Fish, Wildlife and Parks, IBM Corporation, ESRI Corporation, and EOSAT Corporation. Even though we have yet to sign any written agreements, several organizations, including the Forest Service and IBM Corporation, have made verbal commitments of support. Furthermore, through a cooperative agreement with the School of Forestry, we expect to have access to 10 Landsat TM scenes covering approximately 80% of the state that will be purchased later this year with funds from the Montana State Department of Revenue.

On other matters, we conducted a national search for a post-doctoral research associate to oversee the image processing and mapping aspects of the project. We are now in the process of hiring Dr. Zhenkui Ma from the University of Michigan for this position starting in October 1991. By then, we expect to have a renovated lab facility set up with an IBM RS/6000 workstation. Also, we are in the process of developing an expert systems model of the vegetation on a single forested site in western Montana for which ample data are available. In addition, an Ecological Working Group comprised of 2 subgroups is being established to advise on matters related to the vegetation map and animal distributions.

Delineation and Evaluation of the Factors Affecting Grizzly Bear Habitat Fragmentation--A Case Study in the Swan Valley

Project Leader: C. Servheen

Research Associate: P. Sandstrom

Cooperators: U.S. Fish and Wildlife Service; University of Montana; Flathead National Forest; Lolo National Forest; Confederated Salish and Kootenai Tribes; Montana Department of State Lands; Montana Department of Fish, Wildlife and Parks; Plum Creek Timber Company; Missoula, Lake, and Flathead counties

Objectives:

The objective of this research is to develop an analysis technique using Georgaphical Information System (GIS) and vegetative database systems. This technique will display and assess the impacts of fragmentation. Habitat fragmentation may eventually lead to isolation of the Mission Mountains grizzly bear population.

Results:

Project started 1 August 1991. Presently Flathead National Forest Geographic Information has been imported into our GIS system. Further database information will be incorporated and analysis will begin shortly.

## CONSERVATION, EDUCATION, AND PUBLIC RELATIONS

Bart O'Gara, Unit Leader

1 October — Presented a 3-hour lecture, with slides, on Montana carnivores to Montana wildlife class (60 students).

30 October — Took approximately 30 students to the National Bison Range and captured mountain goats for Montana Department of Fish, Wildlife and Parks.

31 October — Presented a 3-hour slide-assisted lecture on capture and immobilization of large mammals to advanced wildlife conservation class (40 senior and graduate students).

9 November — Lectured to animal ecology class on the effects of diseases and parasites on populations of large mammals (35 senior and graduate students).

14 November — Presented a 3-hour slide-assisted lecture on wildlife necropsies to advanced wildlife conservation class (40 senior and graduate students).

15 November — Lectured on identifying predator kills to wildlife techniques class (35 senior and graduate students).

16 November — Immobilized bison calves on the National Bison Range that had not been vaccinated during roundup.

22 January — Presented a 1.5-hour lecture to mammal conservation class on wildlife capture and handling (35 wildlife biology seniors).

26 February — Took 30 students to area near Anaconda and assisted Montana Department of Fish, Wildlife and Parks in the capture of 50 bighorn sheep for transplanting.

26-29 March — Held a workshop on wildlife diseases and parasites for Montana Department of Fish, Wildlife and Parks (18 wardens attended).

Jan.-Mar. — Co-taught a 4-credit course on wildlife diseases and parasites (12 senior and graduate students).

30 April — Presented a 1.5-hour lecture to wildlife issues class on predation (60 nonwildlife students).

1 May — Lectured 1 hour at Cold Springs School on predation (approximately 50 5th and 6th grade students).

4 May — Lectured for half day at the Teachers Outdoor Workshop on the National Bison Range on mountain mammals (30 high school teachers).

18 May — Lectured for half day at Superior School's Outdoor Week on how a scientist works, wildlife management, predation, and pronghorn behavior (35 sixth graders).

21 May — Presented a noon Biological Sciences seminar on "What is Legitimate Wildlife Research" (30 faculty and graduate students).

19-25 May — Hosted visit by Dr. Du Juzing from Peoples Republic of China.

25 June — Interviewed on KYLT T.V. concerning wildlife research in China.

22-23 July — Attended USFWS Region 6/Region 8 meeting in Frisco, Colorado.

24 July — Visited USFWS Region 6 Headquarters in Lakewood, Colorado and presented a noon seminar on Nepal.

5 August — Attended an International Affairs Committee meeting on Univ. Montana campus.

15 August-7 Sept. — Traveled to China to meet with 3 Univ. Montana graduate students doing research there, negotiate a new Sister Institution Agreement between Univ. Montana and the NW Plateau Institute of Biology, and confer with officials in Beijing concerning the new Red Data Book for China.

19-20 Sept. — Worked with Hank Hristienko of the Manitoba Department of Wildlife to work out a protocol for determining reproductive history of 60 black bears from placental scars.

23 Sept. — Met with Montana Department of Fish, Wildlife and Parks and Rocky Mountain Elk Foundation biologists concerning conservation of spring elk habitat in the Missoula Valley.

25 Sept. — Met with Montana Department of Fish, Wildlife and Parks biologists to finalize a slide presentation on elk in the Missoula Valley.

Joe Ball, Assistant Unit Leader

Oct.-Dec. — Taught Big Game Check Station course (35 undergraduate students).

29-31 Oct. — Attended University of Idaho conference entitled: "Gap Analysis: A Workshop on Protecting Biodiversity Using Geographic Information Systems."

5 November Presented lecture in Montana wildlife class (40 students).

6 November Lectured to survey of wildlife careers class on employment with the USFWS (125 students).

7-10 Nov. Gave two lectures at South Dakota State University (Brookings) on duck populations (50 students and faculty).

30 November Interviewed on Radio Station KGVO; topic: Flathead Valley waterfowl research projects.

4 December Hosted meeting of graduate students with J. Stutzman, Bowdoin National Wildlife Refuge.

13 December Gave 2-hour presentation on waterfowl research at Confederated Salish & Kootenai College, Pablo, Mont.

Jan.-Mar. Taught introduction to biological writing (12 graduate students) and bird conservation (30 students).

14 January Guest speaker at Flathead Audubon Society, Bigfork, Mont.; topic: "The Ninepipe Project: Restoring a Balance between Ground-nesting Birds and Their Predators."

26 January Lectured at Aquatic WILD Workshop, Univ. Montana (20 education and environmental studies students).

5 February Guest speaker at Pheasants Forever meeting, Ronan, Mont. (10 members).

11-14 Feb. Attended meeting in Bismarck, N.D. on modelling effects of nest structures on mallard populations.

8-10 April Attended Montana Wildlife Society meetings, Bozeman, Mont.

11 April Presented 2-hour lecture, "Population Declines in Upland Nesting Birds" to wildlife management issues class.

20 April Attended and lectured at Montana Wildlife Federation meeting in Red Lodge, Mont.

23 April Presented wildlife biology seminar on "Why Do Ducks Die--and Does It Matter to Meadowlarks?"

30 April Refereed manuscript for International Canada Goose Symposium.

17 May Presented wildlife biology seminar on "Habitat Fragmentation and Nest Predation: Emerging Parallels between Forest and Grassland Birds."

22 May Attended annual Wetlands Tour.

24 May — Refereed 19-page manuscript for The Prairie Naturalist.

4 June — Attended meeting on "Communication and Networks in the Education of Native Americans in Science and Technology," Univ. of Montana campus.

4 June — Met for 1 hour with Native American high school students, explaining the Unit program.

20 June — Attended Unit Coordinating Committee meeting, Helena, Mont.

9 July — Attended OAS training in Spokane, Wash.

15-17 Aug. — Attended "Managing Predation to Increase Production of Wetland Birds" symposium, Jamestown, N.D.

August — Reviewed and rated all applications for Washington Assistant Leader--Wildlife position.

19 Sept. — Guest speaker at Bitterroot Audubon Society meeting.

Daniel Pletscher

5-6 Dec. — Met with Boone and Crockett Club personnel in Washington, D.C. to discuss Boone and Crockett Chair at Univ. Montana.

3-4 January — Attended 1991 Annual Wolf Working Group meetings in Missoula, Mont.

9 March — Gave presentation to Washington State wildlife class, Clark Fork, Id., "Wolf recovery in the Northern Rockies."

22-27 March — Attended 56th North American Wildlife and Natural Resources Conference, Edmonton, Alberta, Canada.

9 April — Attended Montana Chapter meetings of The Wildlife Society, Bozeman, Mont.

23-27 July — Attended 1991 Border Grizzly/Wolf Technical Committee meetings in Polebridge, Mont.

Roland Redmond

29-30 Oct. — Attended Gap Analysis Workshop, University of Idaho, Moscow.

3 April — Attended USFS, Region 1, Natural Areas Conference, Missoula, Mont.

7 May — Attended Montana GIS Technical Working Group meeting, Blue Bay, Mont.

27-28 June — Attended Gap Analysis Workshop, Univ. California, Santa Barbara.

David Felley

9 February — Interviewed on KIVI-TV, Nampa, Idaho; topic: ring-necked pheasants in southwestern Idaho.

6 April — Attended Idaho Chapter of Pheasants Forever state council meetings in Boise, Idaho.

24-26 July — Attended 17th Annual Western States Sage and Sharp-tailed Grouse Workshop in Pocatello, Idaho.

Fall 1991 — Subject of article, "Research efforts focus on upland birds," in Idaho Fish & Game News, Fall 1991 issue.

Kurt Forman

21 May — Conducted a field trip to the Ninepipe National Wildlife Refuge for 22 7th grade students from the Ronan Middle School, Ronan, Mont.

7 June — Demonstrated selected avian field biology techniques to students of the Biological Field Methods class at the Salish & Kootenai College, Pablo, Mont.

22 June — Gave presentation to the Flathead Resource Organization on waterfowl management in the Flathead Valley.

Salah Hakim

30 May-3 June — Attended symposium on "Environmental Issues in Africa," Oklahoma State University, Stillwater, Oklahoma.

Richard Harris

13 April — Spoke on "Conservation Biology Bumps into Reality in Western China" at Division of Biological Sciences Seminar, Univ. Montana.

16 April — Conducted Asian Studies Seminar on "Status of Tibetan Culture in China," at Univ. Montana.

18 April — Gave guest lecture in wildlife management issues class, "Wildlife on the Tibetan Plateau."

May — Awarded Bertha Morton Scholarship by Univ. Montana School of Forestry.

13 May — Gave presentation on Qinghai-Tibet Plateau at Newark Academy, Livingstone, New Jersey.

20 May — Lectured on using the Chinese language in China to 8th grade language class, Rattlesnake Middle School, Missoula, Mont.

23 May — Lectured to Univ. Montana class, Anthropology 332, Peoples of Inner Asia, on Tibetan culture in Qinghai Province.

6 June — Attended USFS Workshop in Yellowstone National Park on Grizzly Bear Biology, Ecology and Management. Lectured on "Carrying Capacity and Minimum Viable Populations."

13 June — Participated in Montana-China Dialogue sponsored by National Committee for United States-China Relations.

Tom Maeder

13 December — Subject of article in the Twin Falls, Idaho Times-News by Larry Hovey, "Why are pheasant numbers still low?"

6 April — Attended Idaho Chapter of Pheasants Forever state council meetings in Boise, Idaho.

19 April — Interviewed for 22 April article in the Twin Falls, Idaho Times-News, "Night moves on the lek."

3 May — Awarded Bright Memorial Scholarship by Univ. Montana School of Forestry.

24-26 July — Attended 17th Annual Western States Sage and Sharp-tailed Grouse Workshop in Pocatello, Idaho.

22 August — Subject of articles in Twin Falls, Idaho Times-News by Larry Hovey, "Pheasant count steady this season, study finds," and "Alfalfa fields not preferred pheasant cover."

Jeff Marks

Awarded the Paul A. Stewart Award for Ornithological Research by the Wilson Ornithological Society.

Awarded the Hawaii Audubon Society Research Award for ornithological research.

20 June — Refereed manuscript for the Canadian Journal of Zoology.

25 June — Appointed scientific advisor, Western Hemisphere Shorebird Reserve Network.

19 July — Refereed manuscript for the 'Elepaio.

29 July-2 August — Attended joint annual meeting of the Society for the Study of Evolution and the American Society of Naturalists, Hilo, Hawaii.

6 August — Refereed manuscripts for Colonial Waterbirds and the Wilson Bulletin.

27 August — Refereed manuscript for the Journal of Raptor Research.

22 Sept. — Refereed manuscript for the Wilson Bulletin.

Jon Rachael

Awarded Danny On Memorial Scholarship for excellence in wildlife photography by Univ. Montana.

4 January — Attended 1991 Annual Wolf Working Group meetings in Missoula, Mont.

9 April — Attended 1991 annual meeting of Montana Chapter of The Wildlife Society in Bozeman, Mont.

23 July — Attended 1991 Border Grizzly/Wolf Technical Committee meetings in Polebridge, Mont. Reported on research project.

Kevin Roy

15-19 April — Attended Midwest Furbearer Conference in Custer, S.D.

25 April — Gave guest lecture, "Potential endangered status for predatory furbearers in the Northwest" to EVST 599, special topics (endangered predators) class.

27 April — Gave all-day presentation on endangered species to "St. Joseph Middle School Annual Spring Bonanza."

29-31 May — Attended Symposium on the Biology and Management of Martens and Fishers, Laramie, Wyo.

Mark Secord

13 July Spoke on "White-tailed deer of northern Idaho" at USFS Priest Lake Ranger District Campfire Program, Priest Lake, Idaho.

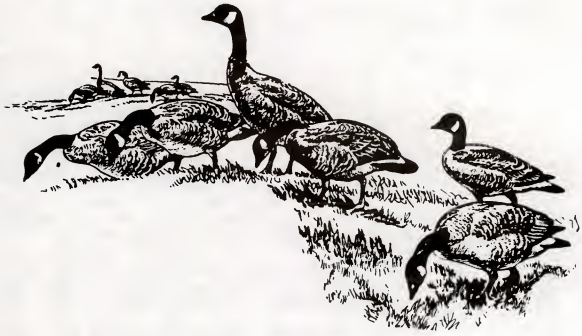
30 August Participated in USFS Priest Lake Ranger District Campfire Program, Priest Lake, Idaho.

Tim Van Deelen

15-19 April Attended Ninth Midwest Furbearer Workshop, Custer, S.D.

Amjad Virk

22-27 March Attended 56th North American Wildlife and Natural Resources Conference, Edmonton, Canada.



## PAPERS PRESENTED

Ball, I. J. 8 April 1991. Habitat fragmentation and nest predation: emerging parallels between forest birds and waterfowl. Montana Chapter, The Wildlife Society, Nongame Symposium, Bozeman, Mont.

Felley, D. L. 17 February 1991. Nesting ecology of ring-necked pheasants in southcentral Idaho. Idaho Wildlife Society meetings, Boise, Id.

Harris, R. B. 6 June 1991. Carrying capacity and minimum viable populations. Grizzly Bear Biology, Ecology and Management meetings, USFS, Yellowstone National Park, Wyo.

Hakim, S. A. 31 May 1991. An African conservation philosophy to save the elephant and enhance development. Environmental Issues in Africa, Oklahoma State University, Stillwater, Okla.

Maeder, T. G. 17 February 1991. Nesting ecology of ring-necked pheasants in southwestern Idaho. Idaho Wildlife Society meetings, Boise, Id.

Marcum, C. L. 9 April 1991. Sexual differences in distribution of elk relative to roads and logged areas in western Montana. Elk Vulnerability Symposium, Bozeman, Mont.

Pletscher, D. H. 20 November 1990. International wildlife. Model United Nations, Missoula, Mont.

_____. 3 January 1991. North Fork ungulate studies. Wolf Technical meetings, Missoula, Mont.

_____. 28 January 1991. Wildlife on the Tibetan Plateau. UM Student Chapter, The Wildlife Society, Missoula, Mont.

_____. 15 March 1991. Biodiversity and the land ethic. Montana Chapter of the Society of American Foresters, Missoula, Mont.

_____. 24 March 1991. Activities of the International Affairs Committee, The Wildlife Society. 56th North American Wildlife and Natural Resources Conference, Edmonton, Alberta, Canada.

_____. 26 March 1991. Managing wolf and ungulate populations in an international ecosystem. 56th North American Wildlife and Natural Resources Conference, Edmonton, Alberta, Canada.

_____. 9 April 1991. Update on wolves in Montana. Montana Chapter of The Wildlife Society, Bozeman, Mont.

_____. 26 July 1991. Black bears and CITES. North Fork Grizzly/Wolf Technical Meetings, Polebridge, Mont.

_____. 11 September 1991. North Fork ungulate/wolf studies. Meeting of Project WILD Instructors, Rocky Mountain Elk Foundation, Missoula, Mont.

Rachael, J. S. 4 January 1991. Mortality and seasonal distribution of white-tailed deer in an area recently recolonized by wolves. 1991 Annual Wolf Working Group Meetings, Missoula, Mont.

_____. 9 April 1991. Mortality and seasonal distribution of white-tailed deer in an area recently recolonized by wolves. Montana Chapter of The Wildlife Society annual meeting, Bozeman, Mont.

_____. 23 July 1991. Mortality and seasonal distribution of white-tailed deer in an area recently recolonized by wolves. Border Grizzly/Wolf Technical Committee meeting, Polebridge, Mont.

Redmond, R. L. 3 April 1991. Montana Gap Analysis Project. USFS, Region 1, Natural Areas Conference, Missoula, Mont.

_____. 7 May 1991. Identification and protection of biodiversity in Montana using a GIS. Montana GIS Technical Working Group meeting. Blue Bay, Flathead Lake, Mont.

Roy, K. D. 17 April 1991. Ecology of reintroduced fishers in the Cabinet Mountains of northwest Montana. Ninth Midwest Furbearer Conference, Custer, S.D.

_____. 31 May 1991. Factors affecting fisher reintroduction success in the Cabinet Mountains of northwest Montana. Symposium on Biology and Management of Martens and Fishers, Laramie, Wyo.

Sheldon, A. L. May 1991. Emergence sampling of large Plecoptera: numbers, precision, phenology and some fitness variables. North American Benthological Society, Santa Fe, N.M.

Sovey, S. J., and I. J. Ball. 24 April 1991. Influence of island size on number and success of Canada goose nests in northwestern Montana. International Canada Goose Symposium, Milwaukee, Wis.

Van Deelen, T. R. 17 April 1991. Juvenile beaver dispersal in western Montana. Ninth Midwest Furbearer Conference, Custer, S.D.

## PUBLICATIONS


Ball, I. J., and S. K. Ball. 1991. Earth-filled culverts as nest sites for waterfowl. Prairie Nat. 23(2):85-88.

Cai, G., Y. Liu, and B. W. O'Gara. 1990. Observations of large mammals in the Qaidam Basin and its peripheral mountainous areas in the People's Republic of China. Can. J. Zool. 68:2021-2024.

Edge, W. D., and C. L. Marcum. 1990. Elk and cattle on public lands: a new look at an old conflict. West. Wildlands 16:12-15.

_____, _____, and S. L. Olson-Edge. 1990. Distribution and grizzly bear, Ursus arctos, use of yellow sweetvetch, Hedysarum sulphurescens, in northwestern Montana and southeastern British Columbia. Can. Field-Nat. 104:435-438.

Fox, J. L. 1991. Status of the snow leopard Panthera uncia in northwest India. Biol. Conserv. 55:283-298.

Harris, R. B., S. G. Fancy, D. C. Douglas, G. W. Garner, S. C. Amstrup, T. R. McCabe, and L. F. Pank. 1990. Tracking wildlife by satellite: current systems and performance. USFWS, Fish and Wildl. Tech. Rep. 30. 52 pp.

Jourdonnais, C. S., and D. J. Bedunah. 1990. Prescribed fire and cattle grazing on an elk winter range in Montana. Wildl. Soc. Bull. 18(3):232-240.

Loggers, C. 1991. Forage availability versus seasonal diets, as determined by fecal analysis, of dorcas gazelles in Morocco. Mammalia 55(2):255-267.

Marks, J. S., R. L. Redmond, P. Hendricks, R. B. Clapp, and R. E. Gill, Jr. 1990. Notes on longevity and flightlessness in bristle-thighed curlews. Auk 107(4):779-781.

O'Gara, B. W., and J. D. Yoakum. 1991. Additional capture methods and habitat suitability criteria for pronghorn translocations. Pages 51-62 in Proceedings of the Fourteenth Biennial Pronghorn Antelope Workshop, Silver Creek, Colo.

Pletscher, D. H., R. R. Ream, R. Demarchi, W. G. Brewster, and E. E. Bangs. 1991. Managing wolf and ungulate populations in an international ecosystem. Trans. North Am. Wildl. Nat. Resour. Conf. 56:539-549.

Ream, R. R., M. W. Fairchild, D. K. Boyd, and D. H. Pletscher. 1991. Population dynamics and home range changes in a colonizing wolf population. Pages 349-366 in R. B. Keiter and M. S. Boyce, eds. The greater Yellowstone ecosystem: redefining America's wilderness heritage. Yale Univ. Press, New Haven, Conn.

Reichel, J. D. 1991. Relationships among coyote food habits, prey populations, and habitat use. Northwest Sci. 65(3):133-137.

Roy, K. D. 1991. Ecology of reintroduced fishers in the Cabinet Mountains of northwest Montana. Page 28 in L. Fredrickson and B. Coonrod, eds. Proc. ninth midwest furbearer workshop. S.D. Dep. Game, Fish and Parks, Pierre.

Van Deelen, T. R. 1991. Juvenile beaver dispersal in western Montana. Page 41 in L. Fredrickson and B. Coonrod, eds. Proc. ninth midwest furbearer workshop. S.D. Dep. Game, Fish and Parks, Pierre.

Yoakum, J. D., and B. W. O'Gara. 1990. Pronghorn/livestock relationships. Trans. North Am. Wildl. Nat. Resour. Conf. 55:475-487.

Back Cover-- Bald eagles were studied along the Columbia River in south-central Washington during 1986-87. During winter, old-growth trees were very important in that area. In general, major perch and roost trees were the tallest, largest in diameter, and most open crowned in the largest, but least dense, stands.

Photo by John Craighead

Radio-telemetry studies of hen pheasants permit the determination of nest success without the intrusive technique of nest searching previously used.

Photo by R. Rickers